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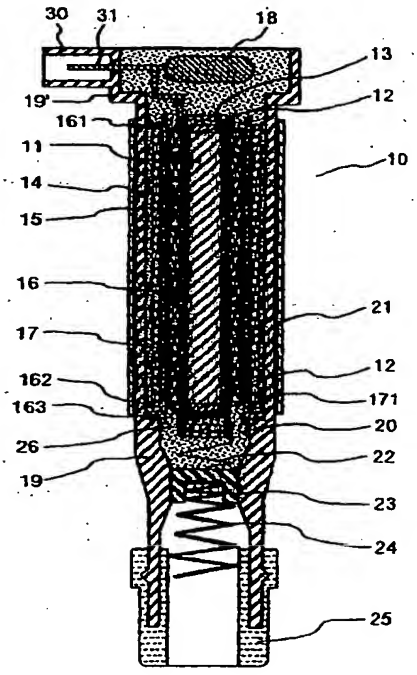
(54) Ignition coil for an internal combustion engine

(57) An ignition coil (10) has a centre core (11) at the centre, a secondary winding (15) wound around a secondary bobbin (14) on outside of said centre core (11), a primary winding (17) wound around a primary bobbin (16) on further outside of the secondary coil, and an insulative resin (20) filled between gaps between these components, two or more flange portions (162, 163) being arranged in the flange portion on the side of high voltage side of the secondary winding among the first bobbin (16), and between the flanges (162, 163), only insulative resin (20) being filled instead of winding the primary winding (17).

FIG. 1



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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to an ignition coil for an internal combustion engine. More particularly, the invention relates to an ignition coil for an internal combustion engine which can be entirely or partly received within a plug hole of the engine.

[0002] Conventionally, an ignition coil received within a plug hole of an internal combustion engine has been known (for example, "Spark Ignition Device for Internal Combustion Engine" disclosed in Japanese Patent Application Laid-Open No. 8-293418(1996) and Japanese Patent Application Laid-Open No. 10-22144(1998).

[0003] The ignition coil of this type is also referred to an independent ignition type ignition coil since it is installed in each individual cylinder. Arrangement of the coil housed within a coil casing is a so-called internal secondary winding system, in which a secondary winding is arranged inside and a primary winding is arranged outside or so called external secondary winding system, in which the primary winding is arranged inside and the secondary winding is arranged outside.

[0004] Amongst, the internal secondary winding system arranges a center core at the center portion of the coil casing, the secondary winding wound around a secondary bobbin surrounding the outer periphery of the center core, and the primary winding wound around a primary bobbin outside of the secondary winding surrounding the outer periphery thereof in coaxial manner.

[0005] Since the ignition coil generates a high voltage to be supplied to an ignition plug, insulation between respective components within the coil casing is ensured by filling and curing a liquid state insulative resin within the coil casing.

[0006] In order to achieve down-sizing of the ignition coil, it has been desired to set a thickness of such insulative region as thin as possible within a range of ensuring insulation ability. Particularly, in case of the ignition coil to be received within the plug hole as set forth above, an external diameter thereof is limited by a diameter of the plug hole. Therefore, it is required to make the thickness of the insulative resin layer located between the primary and secondary windings and that located outside of the primary winding as thin as possible.

[0007] For necessity of reducing the external diameter of the ignition coil and maintaining a predetermined dimension, in the internal secondary winding system, it is typical to take a construction, in which an outer circumference of a flange portion of the primary bobbin abuts onto the inner periphery of the coil casing.

[0008] In the construction where the flange portion of the primary bobbin and the inner periphery of the coil casing are contact, among of the insulative resin penetrating into the contacting portion becomes smaller that that in other portions. Accordingly, the interface at this portion can be easily peeled off during long period of use. Once peeling off is caused, a break down voltage can be lowered to cause leakage between the primary winding 17 and the secondary winding and the high voltage member, such as high voltage terminal to cause difficulty in enhancing duration of insulation.

SUMMARY OF THE INVETION

[0009] An object of the present invention to improve reliability and durability of an ignition coil by enhancing breakdown voltage at an interface between a flange portion of a primary bobbin and a coil casing as set forth above.

[0010] In order to accomplish the above-mentioned object, the present invention basically proposes, in an ignition coil of an internal secondary winding system, two or more flange portions are arranged in the flange portion on the side of high voltage side of the secondary winding among the first bobbin, and between the flanges, only insulative resin being filled instead of winding the primary winding.

[0011] With the construction set forth above, among the primary bobbin, an insulative resin filling region is certainly provided between the flange portions provided in the vicinity of the end portion on high voltage side of the ignition coil. By this, the space between the flange portions serves to provide an anchor effect to make it difficult to cause peeling off between the flange portion and the coil casing located in the vicinity thereof. Even if peeling between the flange portion of the primary winding and the coil casing is caused, bonding ability between the insulative resin filling region and the coil casing can be certainly maintained to enhance breakdown voltage of the interface between the primary bobbin and the coil casing. Furthermore, even if peeling off at the interface between the primary bobbin, the insulative resin and the coil casing, a creepage distance from the first winding to the high voltage member (e.g. secondary winding and high pressure terminal or the like) can be large to successfully prevent insulation failure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012]

FIG. 1 is a section in axial direction of the first embodiment of an ignition coil for an internal combustion engine according to the present invention;

FIG. 2 is a section showing a construction where the shown embodiment of the ignition coil is installed on an engine block;

FIG. 3 is a longitudinal section of a primary bobbin with a primary winding to be used in the embodiment set forth above;

FIG. 4 is a perspective view of the primary bobbin in the shown embodiment;

FIG. 5 is a longitudinal section showing another example of the primary bobbin in the second embod-

iment of the present invention;
FIG. 6 is a longitudinal section showing a further example of the primary bobbin in the third embodiment of the present invention;
FIG. 7 is a perspective view of the primary bobbin in the fourth embodiment of the present invention;
FIG. 8 is a longitudinal section of the primary bobbin in the fifth embodiment of the present invention; and
FIG. 9 is a section in axial direction of the fifth embodiment of the ignition coil for the internal combustion engine.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0013] An embodiment of the present invention will be discussed hereinafter in terms of the embodiment illustrated on the drawings. In each drawing, like reference numerals identify like components.

[0014] Fig. 1 is a longitudinal section of one embodiment of an ignition coil for an internal combustion engine according to the present invention, and Fig. 2 is a longitudinal section of a condition where the foregoing ignition plug is installed within a plug hole.

[0015] In Fig. 2, 1 denotes an internal combustion engine, 2 denotes a cylinder head in an engine block. An ignition coil 10 is entirely or partly inserted within a plug hole 5 of the cylinder head and is electrically connected to an ignition plug 3. 4 denotes a combustion chamber of the engine.

[0016] In Fig. 1, a casing of the ignition coil 10 is constructed with a coil casing 19 housing a coil parts and a circuit casing (hereinafter referred to as igniter casing) 19' housing a spark ignition driver circuit (hereinafter referred to as igniter) 18.

[0017] The igniter casing 19' is formed integrally with a connector casing 30. In the connector casing 30, a plurality of terminals 31 are arranged (in the drawings, only one terminal 31 is illustrated for convenience of illustration, but in practice, there are power source terminal, a grounding terminal and a signal terminal).

[0018] Within the coil casing 19, a center core 11 is arranged at the center portion. On the outside of the center core, a secondary winding 15 wound around a secondary bobbin 14 is arranged, On the outside of the secondary winding 15, a primary winding 17 wound around a primary bobbin 16 is arranged. The first and second bobbins 14 are formed of an insulative resin, such as PPS, PGT, Noryl or the like.

[0019] One end on winding start side of the primary winding 17 and one end on low voltage side of the secondary winding 15 are connected to a common power source terminal (positive side). The primary winding 17 is a double layer winding, for example (in Fig. 1, it is shown as single layer winding for convenience of illustration). Winding is started on the side of a flange portion 161 provided at one end of the primary bobbin 16. When the first layer of winding reaches a flange portion provided on the other end of the bobbin 16, it is turned to start winding of the second layer from the side of the flange portion 161. One end on winding end side is connected to a grounding terminal. For the primary bobbin 16, in addition to the flange portion portions 161 and 162 defining a winding region of the primary winding, a flange portion 163 for another purpose is provided. The flange portion 163 is for enhancing insulation performance between the primary winding and a high voltage member (secondary winding, high voltage terminal and so forth) in cooperation with the flange portion 162. This point will be discussed later.

[0020] The secondary winding is divided via a plurality of flange portions on the secondary bobbin 14 to have higher voltage toward winding end side (one end of the secondary bobbin). The end portion of the secondary winding on the winding end side is electrically connected to a connection spring 22 for high voltage and thus to a high voltage terminal 23,

[0021] A high voltage diode 26 is installed on the high voltage side end of the secondary bobbin 14. 12 denotes a permanent magnet, 13 denotes a rubber like elastic member having insulation ability, and 21 denotes a side code mounted on the outer periphery of the coil casing.

[0022] After housing the ignition coil parts and the electronic circuit within the coil casing 19 and the igniter casing 30, a liquid state insulative resin (e.g. epoxy resin) is injected to fill and cure for forming the insulative resin portion 20.

[0023] On the lower end of the coil casing 19, a rubber boots 25 is fitted. Through the rubber boots 25 and a spring 24, the ignition plug 3 (see Fig. 2) is secured.

[0024] By operation of the igniter 18, flow of the primary current through the primary winding 17 is conducted and blocked. Then, high voltage of 20 KV to 40 KV is generated on the secondary winding 15 and output to the ignition plug 3. A spark is then caused in an electrode portion of the ignition plug 3 to cause spark ignition of a compressed mixture in the combustion chamber 4.

[0025] In the construction set forth above, an interface between the outer periphery of the flange portion 162 of the primary bobbin and the inner periphery of the coil casing 19 tends to cause peeling off to be a cause of lowering of breakdown voltage. Lowering of the breakdown voltage can be a cause of leakage of high voltage between the primary winding 17 and the high voltage member such as the secondary winding 15 and high voltage terminal 23.

[0026] In order to avoid such shortcoming, in the shown embodiment, among the primary bobbin 16, another flange portion 163 is provided in addition to the flange portion 162 on the high voltage side end of the secondary winding. Between the flange portions 162 and 163, the primary winding is not wound and only insulative resin is filled.

[0027] Fig. 3 is an illustration showing a longitudinal section of the primary bobbin 16, on which the primary winding 17 is wound, and Fig. 4 is an illustration showing

a perspective view of the primary bobbin 16.

[0028] Namely, the primary bobbin 16 is arranged two flange portions 162 and 163 on high voltage side of the ignition coil.

[0029] Between the flange portion 162 and the flange portion 163, an insulative resin filling region where the primary winding is not present, is provided. By this, the insulative resin between the flange portions 162 and 163 serves for providing an anchor effect to make it difficult to cause peeling off between the flange portions 162, 163 and the coil casing 19. Even if peeling is caused between the flange portion and the coil casing, since bonding ability between the insulative resin filling region and the coil casing can be maintained to make the breakdown voltage at the interface between the primary bobbin and the coil casing high. Furthermore, even if peeling at the interface is caused in any one of the primary bobbin, the insulative resin and the coil casing, for large creepage distance between one end 171 of the primary winding and the high voltage member, such as the high voltage side of the secondary winding 15 or the high voltage terminal 23 or the like, insulation failure between the primary winding and the high voltage member can be suppressed. Accordingly, breakdown voltage between one end 171 of the primary winding and the high voltage member can be improved to avoid insulation failure from occurring.

[0030] A distance between the flange portion portions 162 and 163 has to be large enough to sufficiently impregnate the insulative resin. As an example, it should be a dimension greater than or equal to the minimum thickness of the flange portion, e.g. greater than or equal to 1 mm.

[0031] It should be noted that, in a search of known art performed by the owner of the instant application, in external secondary winding system (in which the primary winding is arranged inside and the secondary winding is arranged outside), the ignition coils having a plurality of flange portions not having multi-layer winding, and arranged at high voltage side end of the secondary bobbin have been found in Japanese Patent Application Laid-Open No. Heisei 10-256062 and Japanese Patent Application Laid-Open No. Heisei 8-255718, for example. However, the function of the space between the flange portion portions in these known art is to eliminate concentration of electric field which can be cause when lead line on the high voltage side of the secondary winding is led to the high voltage terminal by single conductor, by winding the high voltage lead wire between the flange portions in single layer to lead to the high voltage terminal. Therefore, these performs different function to the present invention, and no prior art which can expect the function and effect as achieved by the present invention has been present.

[0032] Figs. 5 to 8 show sections or perspective view showing modification of the primary bobbin to be employed in the foregoing embodiment.

[0033] Fig. 5 shows an example, in which opposing surfaces of the foregoing flange portions 162 and 163 of the primary bobbin 16 are tapered to be widen toward outside. By such construction, the creepage distance from the coil end 171 of the primary winding and the high voltage member becomes further greater. Furthermore, die cutting can be facilitated.

[0034] In an example of Fig. 6, one of two flange portions 162 and 63 of the primary winding (inner flange portion 162 in shown case) is provided smaller height in radial direction than the other flange portion 163 in the extent of ΔAh. For example, the height of the flange portion 163 is 1.2 mm and the height of the flange portion 162 is 0,7 mm to set the ΔAh about 0.5 mm.

[0035] With such construction, positioning of the primary bobbin in the radial direction can be done by the flange portion 163 having greater flange portion height, and a gap of ΔAh is maintained between the flange portion 162 having smaller flange portion height and the coil casing to permit filling of the insulative resin in rich within the gap portion to improve bonding ability between the flange portion 162 and the coil casing to increase breakdown voltage at the interface between the flange portion and the coil casing and to further certainly suppress occurrence of insulation failure between the primary winding and the high voltage member.

[0036] The primary bobbin 16 shown in Fig. 7 is provided with groove portions 161a to 163a in axial direction of the flange portions 161 to 163 set forth above. By providing threes groove portions, flowability of the liquid state insulative resin upon injection of the insulative resin.

[0037] One of more of these grooves are arranged on each flange portion portion. On the other hand, the groove portions 162a and 163a provided on the flange portions 162 and 163 are arranged in staggered fashion so as not to overlap with the coil casing (ignition coil).

[0038] With the construction set forth above, flowability of the insulative resin becomes satisfactory to make the insulative resin rich as injected around the high voltage member to suppress occurrence of local failure which can cause void discharge in the insulative resin 20. Furthermore, since the creepage distance between the primary winding 17 and the high voltage member can be made large to restrict insulation failure.

[0039] In the embodiment shown in Fig. 8, among a plurality of flange portions 162 and 163 in the primary bobbin 16, the flange portion 163 on the side close to the high voltage side of the ignition coil (shortest side of the bobbin) is provided a ridge 163b. The ridge 163b is formed on the side surface directed to the high voltage side of the ignition coil in the flange portion 163.

[0040] The ridge portion 163b has a structure to engage with a recessed portion 33 provided in the primary bobbin receptacle portion of the coil casing as shown in Fig. 9 to provide greater insulation distance (creepage distance) between the primary winding 17 and the high voltage member. Accordingly, insulation failure between the primary winding 17 and the high voltage member

can be more certainly prevented.

[0041] While discussion has been given for the case where the two flanges are provided on the high voltage side of the primary winding bobbin 16, it is possible to provide more than or equal to two high voltage side flanges. In such case, the creepage distance can be further greater. Also, since the insulative resin 20 may be filled between respective flanges to make suppression of occurrence of insulation failure.

[0042] With the present invention, the breakdown voltage at the interface between the flange position of the primary bobbin and the coil casing can be enhanced. Also, since the creepage distance between the primary winding to the high voltage member, such as the secondary winding, the high voltage terminal or the like becomes large to restrict insulation failure between the primary winding and the high voltage member.

Claims

1. An ignition coil (10) for the internal combustion engine (1) formed by arranging a centre core (11) at the centre, a secondary winding (15) wound around a secondary bobbin (14) on outside of said centre core (11), a primary winding (17) wound around a primary bobbin (16) on further outside of the secondary coil, and an insulative resin (20) filled between gaps between these components,
wherein two or more flange portions (162, 163) being arranged on the side of high voltage side of the secondary winding (15) among the primary bobbin (16), and between the flanges (162, 163), only insulative resin being filled instead of winding the primary winding (17).

2. An ignition coil (10) for an internal combustion engine (1) as set forth in claim 1, a distance between said flange portions (162, 163) is a dimension to be more than or equal to the minimum thickness of the flange portion.

3. An ignition coil (10) for an internal combustion engine (1) as set forth in claim 1 or 2, wherein height of at least one of the flange portion (162, 163) is made smaller than the other.

4. An ignition coil (10) for an internal combustion engine (1) as set forth in claim 1, wherein said flange portion has one or more groove in the axial direction, and respective grooves (162a, 163a) of the flange portions (162, 163) are arranged so as not to overlap in longitudinal direction.

5. An ignition coil (10) for an internal combustion engine (1) as set forth in any one of claims 1 to 4, wherein the flange portion (163) arranged at the closest to the high voltage side among said flange portions (162, 163) has a ridge portion (163b) on the side surface directed to the high voltage side, and said ridge portion (163b) engages with a recessed portion (33) provided in a primary bobbin receptacle portion of said coil casing (19).

FIG. 1

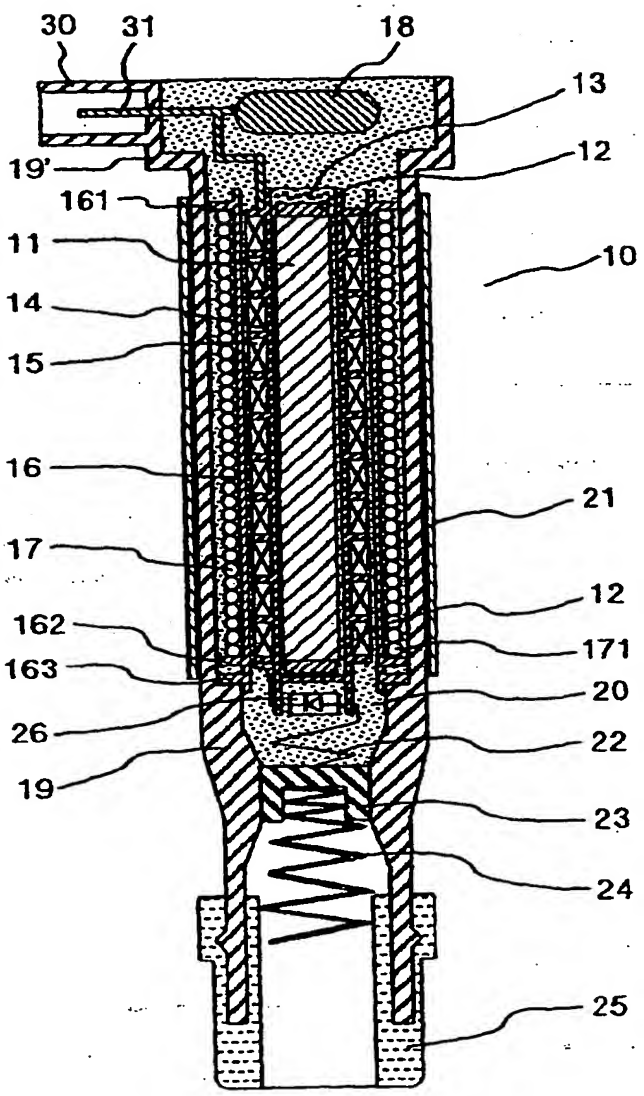

30
31
18
13
19'
12
161
11
10
14
15
16
21
17
12
162
171
163
20
26
22
19
23
24
25

FIG. 2

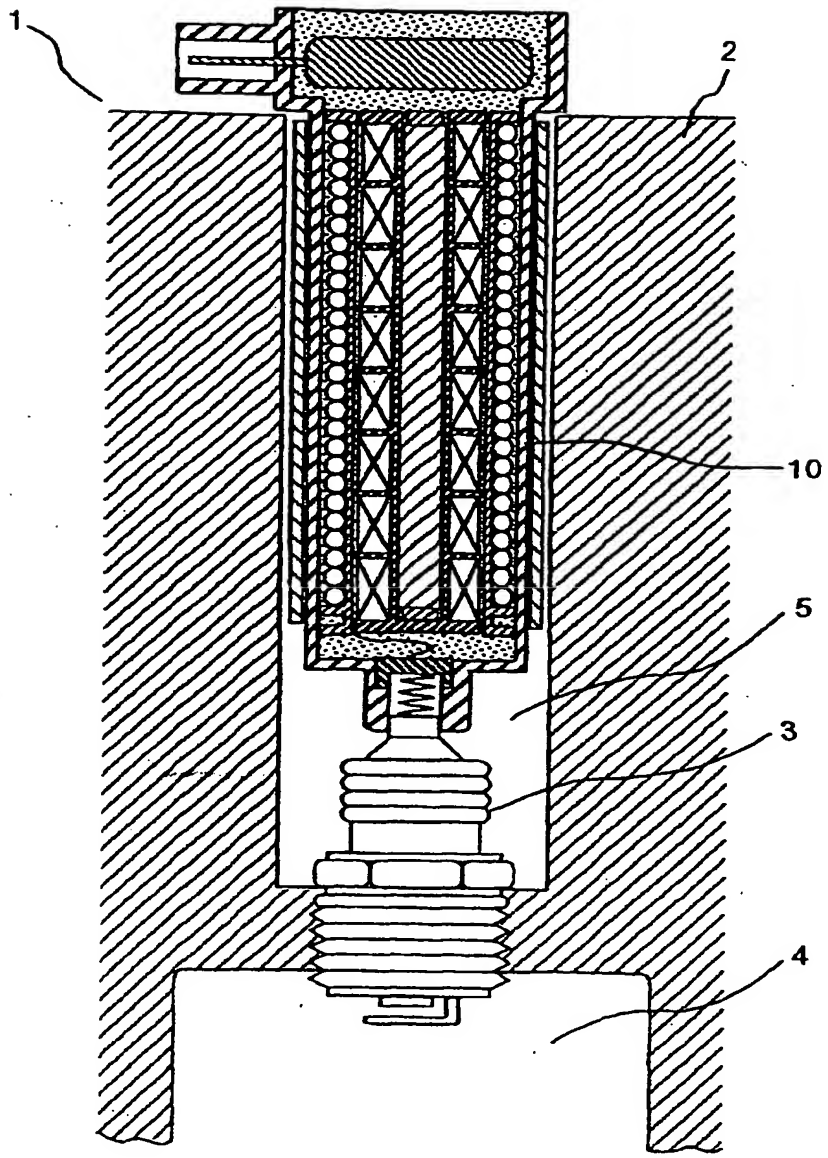


FIG. 3

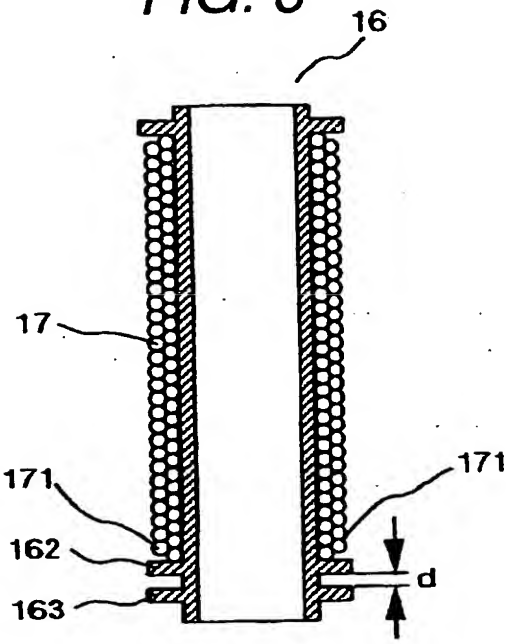


FIG. 4

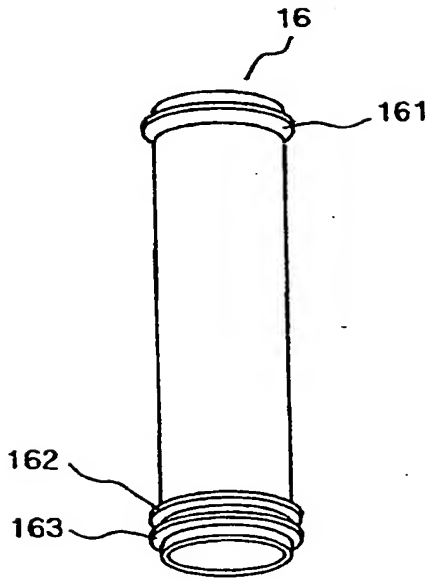


FIG. 5

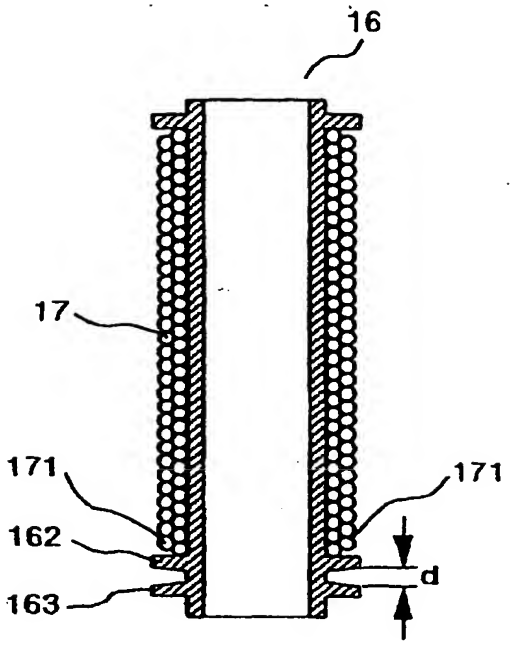


FIG. 6

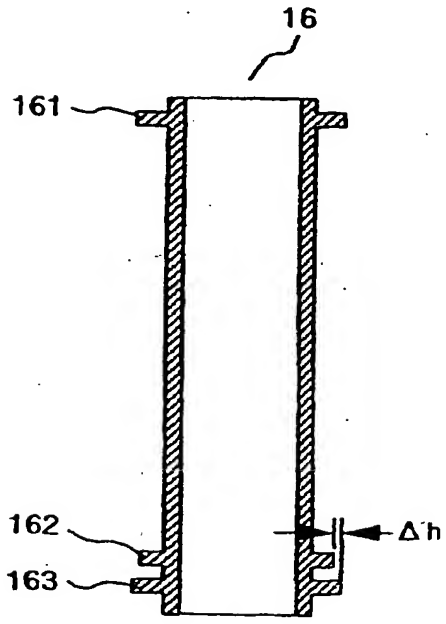


FIG. 7

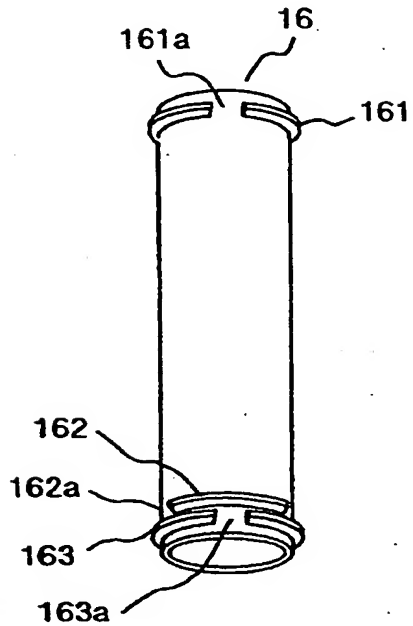


FIG. 8

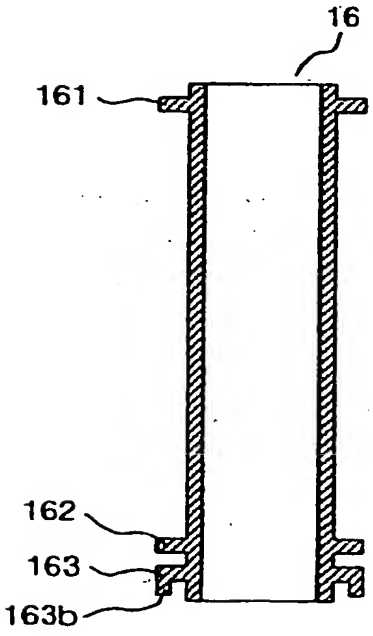
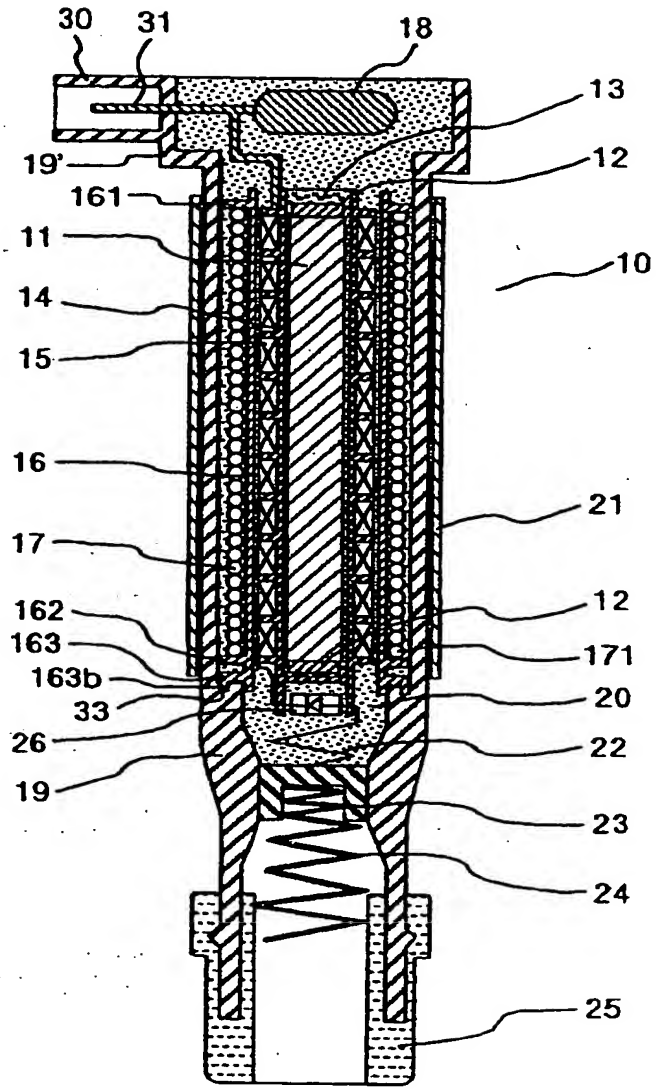


FIG. 9



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EUROPEAN SEARCH REPORT

Application Number
EP 01 10 4407

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	PATENT ABSTRACTS OF JAPAN vol. 1997, no. 06, 30 June 1997 (1997-06-30) & JP 09 045571 A (HANSHIN ELECTRIC CO LTD), 14 February 1997 (1997-02-14) * figure 3 *	1	H01F38/12 H01F27/32
A	WO 92 07370 A (BOSCH GMBH ROBERT) 30 April 1992 (1992-04-30) * page 2, last paragraph - page 3, paragraph 10; figure 2 *	1	

TECHNICAL FIELDS SEARCHED (Int.Cl.7)

H01F
F02P

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	12 June 2001	Marti Almeda, R

CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 01 10 4407

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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12-06-2001

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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WO 9207370 A	30-04-1992	DE 4032280 A	16-04-1992
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